Space Weather Technical Forecast

Issued on Thursday, 02 March 2023 at 01:22 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Likelihood of M-class flares, with slight chance of X-flares, primarily from AR3234. Active fluence expected to continue until at least 04 Mar.
Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate, with one M1.0 flare observed at 01/0107UTC from AR3236, a large and complex region in the northwest quadrant, quickly followed by a C9.3 flare from AR3240, a newly developing region in the southeast. The C9.3 flare appears to have led to a CME, although give the location and weakness on available imagery, this does not appear to be potentially Earth directed. A C4.2 flare from AR3236 in the southwest at around 01/1330UTC appears to be the source of a CME which has been analysed, with a possible Earth-directed component based on the source location. Three new regions have rotated onto the northeast quadrant in the last 24 hours, with all three difficult to analyse based on location, but will continue to be monitored. The remaining regions are all weak or stable. No further possible Earth-directed CMEs have been observed on available imagery.

Solar Wind / Geomagnetic Activity: Solar wind speeds observed at L1 have declined through the last 24 hours from 650km/s to close to 500km/s as the Earth leaves the influence of the high speed stream from coronal hole 79. Density is below average on a steady trace. Total magnetic field strength has been weak and steady at around 6nT, with the north-south component, Bz weakly positive throughout. The phi angle started negative, but rotated to weakly positive orientation at around 01/0100UTC, but has since become near neutral. Geomagnetic activity started Unsettled, but has been Quiet for much of the period.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 has returned to background levels over the last 24 hours. Electron flux has been above the high threshold through the period, peaking at 3.73e3pfu at 01/1900UTC. Electron fluence has been following a rising trend and reach 1.8e8 integrated pfu at 01/0000UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Low to Moderate activity is expected with a slight chance of Strong activity, mainly from AR3234 in the northwest quadrant.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs are forecast. An ongoing high speed stream is expected to wane to background during 02 Mar. A further coronal hole high speed stream is then forecast to connect with Earth on 04 March, possibly producing speeds of 600-650km/s. This is then likely to continue into 05 Mar. Geomagnetic activity is expected to be mainly Quiet on 02 and 03 Mar, then increase to Active with a chance of G1/Minor Storms on 04 Mar. A reduction in activity is then possible later on 05 Mar.

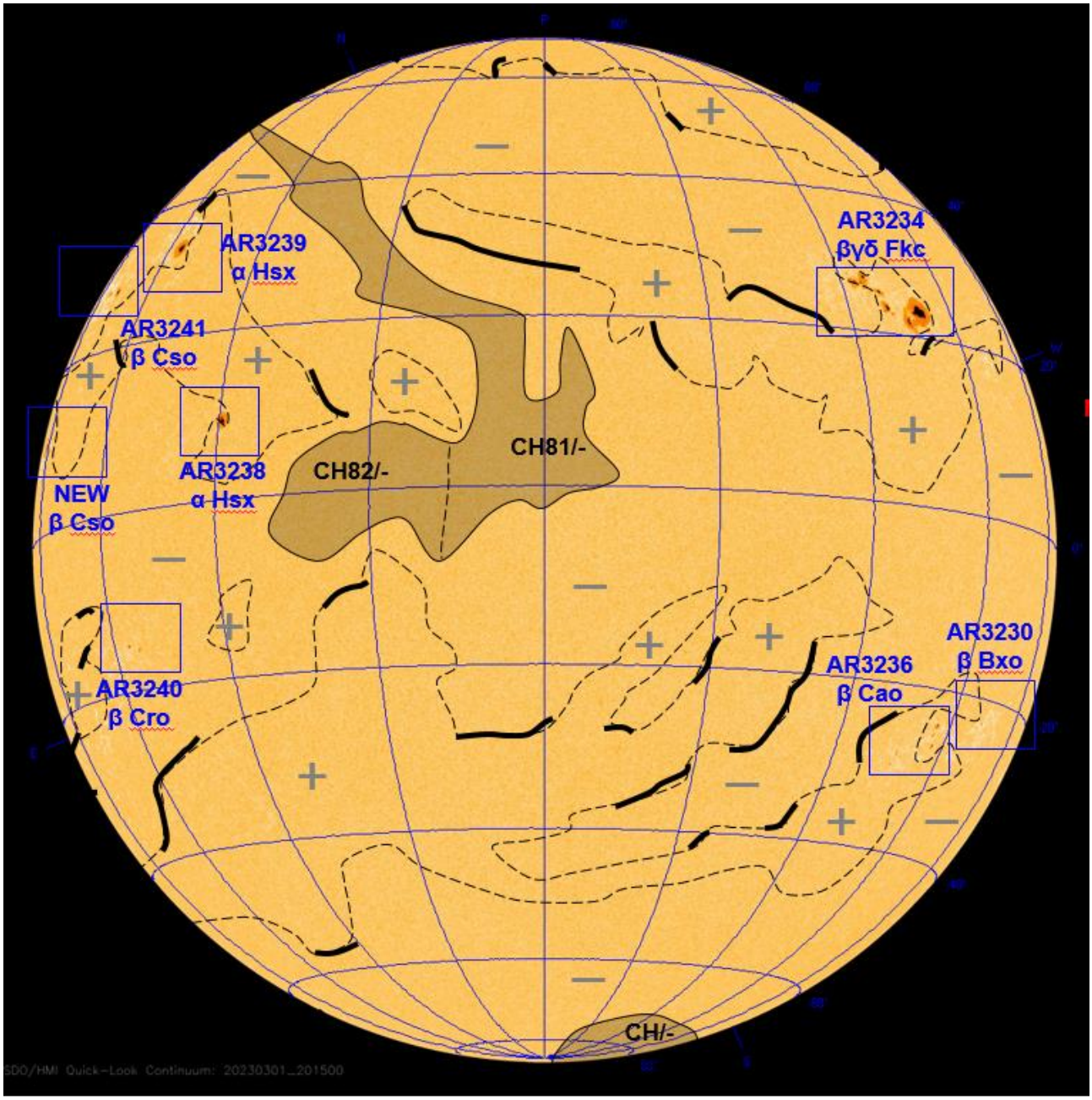
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Met Office Space Weather Technical Forecast

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 2MeV) is at background levels with a slight chance of S1/Minor Storms, mainly from AR3234. Electron flux is expected to remain above the high level through 02 and 03 Mar, with a likelihood that the value will then reduce on 04 Mar in the presence of enhanced geomagnetic activity and solar wind speeds. Electron fluence is expected to persist above the Active (1e8 integrated pfu) level through 02 and 03 Mar, before declining due to anticipated reductions in the electron flux.

Figure 1. Solar Analysis Valid 01/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Geomagnetic Storms:

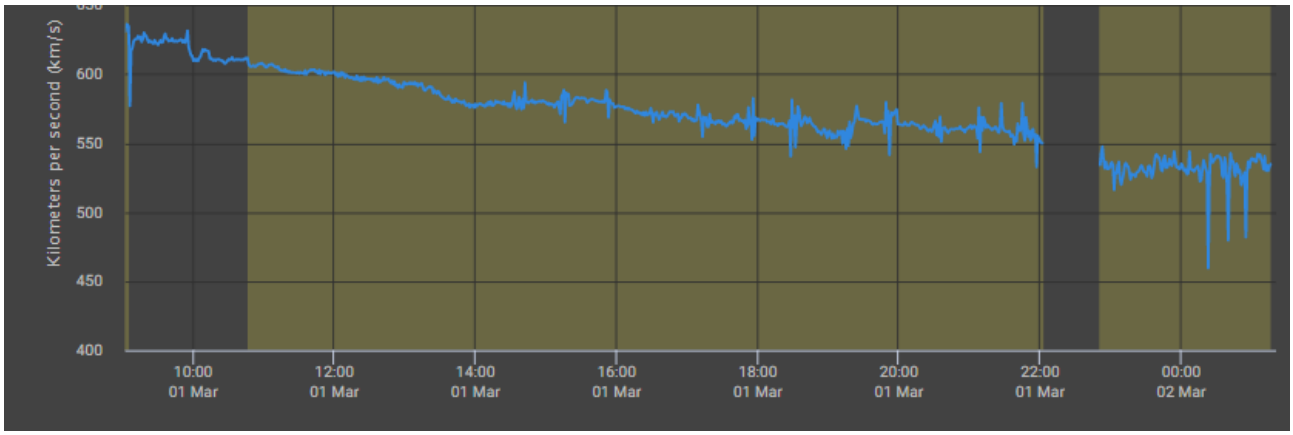
No CMEs are forecast but an eruption from the southwest around 01/1330UTC has been submitted for modelling, to determine if it has an Earth-directed component.

The high speed stream from coronal hole 79 is currently weakening and should ease completely by 02 Mar. A further high speed stream from coronal holes 81 and 82 is expected to connect with Earth on 04 Mar, with effects forecast to continue into 05 Mar. This hole is a recurrent feature which produced speeds of 500-600km/s on the previous rotation. However this is now a larger and more distinct feature, with speeds perhaps reaching above 600km/s.

Geomagnetic activity is expected to be mainly Quiet through 02 and 03 Mar, perhaps reaching Active or G1/Minor Storm levels on 04 Mar and possibly into 05 Mar.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	20	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: L1 solar wind speed, indicating a marked reduction in speed



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

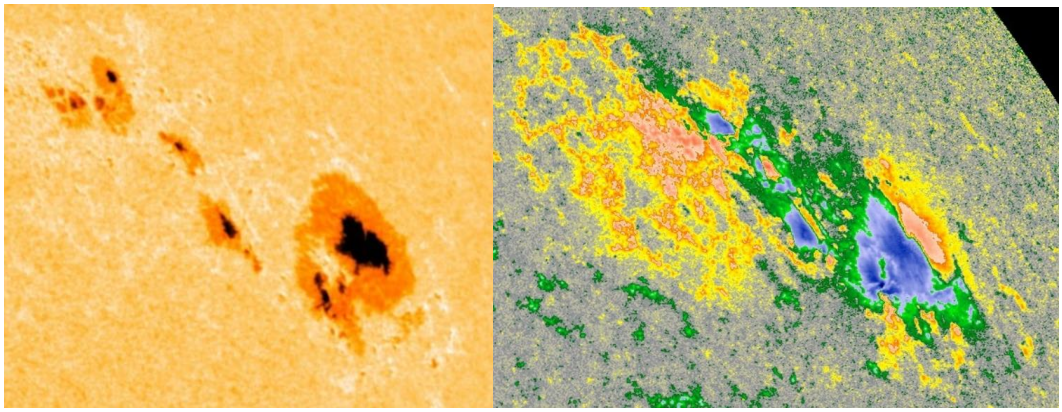
© Crown Copyright 2023. All Rights Reserved.

Radio Blackouts - X-Ray Flares:
AR3234 in the northwest, appears to have simplified through the last 24 hours, but still contains a delta region, with high flare potential from AR3240 in the southeast, which despite appearing weak, has produced a high energy C-class flare in the last 24 hours. Three new regions have rotated onto the visible disc from the far side in the last 24 hours. The viewing angle makes a detailed diagnosis of the structure and complexity of these regions difficult, but they appear to be associated with large areas of magnetic flux, so will continue to be monitored. A number of small and relatively inactive sunspot regions are also scattered over the solar disc.

Solar activity is expected to be mainly Low to Moderate, with a slight chance of Strong activity.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	50	50
Very Active	R3 to R5 X Class	No	20	20	15	10

Figure 3: AR3236 (Fkc/βγδ) in the northwest quadrant, with a delta spot still apparent in the trailer region.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux, as observed by GOES16 has reached background levels. Although no significant flares have been observed recently, the position and complexity of AR3234 presents the largest risk of proton rich flares of any regions on the visible disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) is at high levels and is expected to remain above this level through 02 and 03 Mar. A decline is possible on 04 Mar due to the effects of both a strong high speed stream and increased geomagnetic activity. A return to mainly high levels is then possible later on 05 Mar as geomagnetic activity slowly declines.

Electron fluence values are expected to remain above the Active (1e8 integrated pfu) level through 02 and 03 Mar, declining due to the forecast high speed stream onset. Although likely that values could remain above the threshold on 04 Mar, a sharp decline is then possible later in the day.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	99	80	60	50
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	10	10	10	5

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 4: Goes-16 electron flux and MOSWOC REFM model

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.